THE GERONTOLOGICAL SOCIETY OF AMERICA®

Journals of Gerontology: Medical Sciences
cite as: *J Gerontol A Biol Sci Med Sci*, 2017, Vol. 00, No. 00, 1–8
doi:10.1093/gerona/glx117
Advance Access publication June 16, 2017

OXFORD

Research Article

Physical Activity Attenuates Total and Cardiovascular Mortality Associated With Physical Disability: A National Cohort of Older Adults

David Martinez-Gomez, PhD,[1] Pilar Guallar-Castillon, MD, PhD,[2,3] Sara Higueras-Fresnillo, MSc,[1] Esther Garcia-Esquinas, MD, PhD,[2] Esther Lopez-Garcia, PhD,[2,3] Stefania Bandinelli, MD,[4] and Fernando Rodríguez-Artalejo, MD, PhD[2,3]

[1]Department of Physical Education, Sport and Human Movement, Faculty of Teacher Training and Education, Universidad Autónoma de Madrid, Spain. [2]Department of Preventive Medicine and Public Health, School of Medicine, Universidad Autónoma de Madrid/IdiPaz, CIBER of Epidemiology and Public Health (CIBERESP), Spain. [3]IMDEA-Food Institute and CEI UAM+CSIC, Madrid, Spain. [4]Geriatric Unit, Local Health Tuscany Center, Florence, Italy.

Address correspondence to: David Martinez-Gomez, PhD, Department of Physical Education, Sport and Human Movement, Facultad de Formación de Profesorado y Educación, Universidad Autónoma de Madrid, Campus de Canto Blanco, Ctra. de Colmenar Km 11, E-28049, Madrid, Spain. E-mail: d.martinez@uam.es

Received December 6, 2016; Editorial Decision Date June 9, 2017

Decision Editor: Stephen Kritchevsky, PhD

Abstract

Background: Regular physical activity (PA) has been shown to protect against disability onset but, once the disability is present, it is unclear if PA might attenuate its harmful health consequences. Thus, we examined if mortality risk associated with physical disability can be offset by PA among older adults.

Methods: We used data from a cohort of 3,752 individuals representative of the noninstitutionalized population aged 60 years and older in Spain. In 2000–2001, participants self-reported both PA levels (inactive, occasionally, monthly, weekly) and five physical disabilities (agility, mobility, global daily activities, instrumental activities of daily living, and self-care). Individuals were prospectively followed through 2014 to assess incident deaths.

Results: The mean follow-up was 10.8 years, with a total of 1,727 deaths, 638 of them due to cardiovascular disease (CVD). All disability types were associated with higher total and CVD mortality. Being physically active (ie, doing any PA) was associated with a statistically significant 26%–37% and 35%–50% lower risk of total and CVD death, respectively, across types of disability. As compared with those being physically active and without disability, those who were inactive and had a disability showed the highest mortality risk from total (hazard ratios from 1.52 to 1.90 across disabilities, all $p < .05$) and from CVD (hazard ratios from 1.99 to 2.24 across disabilities, all $p < .05$). Total and CVD mortality risk was similar in physically active participants with disabilities and in inactive individuals without disability.

Conclusions: In older adults, PA could attenuate the increased risk of mortality associated with physical disability.

Keywords: Aging, Survival, Inactivity, Functional limitations

Disability is a complex phenomenon whose frequency increases with age and, therefore, is most prevalent among the oldest old (1–3). Population aging is contributing to a growing number of disabled older adults, which adds burden to the already stressed health- and social-care systems. There are many types of disabilities including those affecting physical and mental functioning; specifically, some types of physical disability (eg, mobility and movement impairments, and limitations of daily living activities) are highly prevalent in the older population (1–3). Moreover, older adults with physical disability are at risk of institutionalization and death (2–4). Consequently, improvement of the health status of these disabled older adults must be a priority for health care organizations and systems.

Regular physical activity (PA) has been shown to protect against the processes that trigger and accelerate the onset of disability (5–8) but, once the disability is present, further research is needed to confirm that PA might attenuate its harmful health impact (6). In particular, there is convincing evidence that a physically active lifestyle is associated with lower total and cardiovascular mortality among individuals from the general population, but evidence among disabled older adults is sparse (8) and the potential health benefits of PA may vary between specific disabilities (5–8). Therefore, we used data from a nationally representative cohort of older adults in Spain to examine (i) the association of PA with mortality from all causes and cardiovascular disease (CVD) among individuals with specific physical disabilities and (ii) the joint associations of PA and physical disability type with total and CVD mortality among older adults.

Methods

Study Design and Participants

For the present study, we used data from the Universidad Autonoma de Madrid (UAM) cohort, comprising 4,008 noninstitutionalized individuals aged 60 years and older in Spain (4,9). The UAM-cohort was established between 2000 and 2001 using probabilistic sampling by multistage clusters. First, the clusters were stratified according to the region of residence and size of municipality. Second, census sections and households were selected randomly within each cluster. Lastly, study participants were selected in sex and age groups. The final study participation rate was 71%. Information at baseline was collected in the participants' home through personal interviews and physical examination by trained and certified personnel. Written informed consent was obtained from study participants and from an attending family member. The Clinical Research Ethics Committee of the *La Paz* University Hospital (Madrid, Spain) approved the study.

Main Study Variables

Physical disabilities were assessed through questions selected from previous scales about the difficulty experienced or the need of help in performing 14 activities, which were subsequently classified into the following five types (10,11): agility, mobility, daily activities, instrumental activities of daily living (IADLs), and self-care. Agility disability was defined in the present study as an affirmative answer to the following question from the Nagi scale (12): "Do you experience any difficulty in bending or kneeling?" Mobility disability was defined as an affirmative answer to any of the following two questions from standardized scales (12–14): (i) "Do you experience any difficulty in climbing one flight of stairs?" or (ii) "Do you experience any difficulty in walking several city blocks (a few hundred meters)?" Participants with disability in (global) daily activities and participation restrictions were identified with an affirmative response to the following question based on the International Classification of Functioning, Disability and Health (15): "During the past 4 weeks, did you have to refrain from doing any of your daily activities, because of your physical health?" IADL disability was assessed with the Lawton & Brody scale (16). This scale evaluates the individual's ability to use the telephone, go shopping, prepare meals, do housework, do laundry, use different means of transportation, take medications, and manage finances. Due to cultural reasons, the questions on meal preparation, housework and laundry were excluded in men; summary scores ranged from 0 (no disability) to 5 in men, and from 0 to 8 in women, and a score of 1 or higher corresponds to an IADL limitation. Finally, self-care disability was defined as an affirmative answer to the following question including the two first items from the Katz index (17): "Do you experience any difficulty in bathing or dressing yourself?"

PA was assessed with the following question taken from the Spanish National Health Survey, which is habitually used to monitor the prevalence of physically inactivity in Spain (18): "Tell me which of these choices best describes most of your leisure-time PA performed in the last 12 months: (i) inactive, (ii) occasional, (iii) several times a month, and (iv) several times a week." Examples of physical activities and questions on differences between categories were answered by the interviewer when required. This question has shown acceptable concurrent validity against the well-validated questionnaire used in the Nurses' Health and Health Professionals' Follow-up studies (19,20) for assessing PA in older adults (18). In the validation study, the Spearman correlation coefficients between both instruments for both sexes, men, and women were 0.55, 0.48, and 0.56, respectively (all $p < .001$); in addition, mean (95% CI) PA energy expenditure for who reported to be inactive, occasional PA, PA several times a month, and PA several times a week were 7.1 (6.2–8.1), 30.0 (28.9–31.0), 43.1 (36.3–50.0), and 56.6 (37.6–75.5) MET-hour/week, respectively (18). Since according to previous evidence (21) at least 50% of walking among older people is performed at low-intensity (<3 METs), and the PA questionnaire does not include information on walking pace, in the validation study, for inactive individuals the MET-hour/week was 2.7 (2.1–3.4) when removing the average time spent walking, and 4.9 (4.2–5.8) when including only 50% of walking duration (18).

The outcome variables were total and cardiovascular mortality from the study baseline (2000/2001) through the end of follow-up at December 31, 2014. The number, cause, and date of deaths were obtained by a computerized search of the National Death Index of the Ministry of Health and the death certificates deposited at the National Institute for Statistics. The number of participants who were dead was successfully ascertained for 99.9% of the cohort. The underlying cause of death was determined by a nosologist according to the International Classification of Diseases, Tenth Edition, with CVD defined as codes I00-I78.

Covariates

Sex, age, and the highest educational level attained (no formal education, primary, and secondary or higher) were recorded. Individuals also reported whether they were current-, former-, or never-smokers. Alcohol consumption was obtained with the frequency-quantity scale used in the Spanish National Health Survey (22). Participants initially rated their alcoholic beverage consumption among the following options: never drinker, former drinker, and current or sporadic drinker. To calculate total alcohol intake, those participants who indicated current or sporadic drinking also reported the frequency and quantity of wine, beer, and spirits consumed during the last year. The cutoffs between moderate and excessive alcohol consumption was alcohol intake >30 and >20 g/d for men and women, respectively.

Body weight and height were measured using standardized procedures and the body mass index was calculated as weight in kg divided by height in square meters (kg/m^2) (9). Waist circumference was measured with an inelastic belt-type tape at the intermediate point between the lowest rib and the iliac crest after breathing out normally (9). Two sets of six blood pressure measurements were obtained by trained observers in the right arm at the level of the heart using standardized methods (23). Readings were taken at 2-minute intervals, with the mean of the measurements used in the analysis. Participants were also asked: "Has your doctor ever told you whether you have high (blood) cholesterol?" If the answer was affirmative or they are under lipid-lowering drug treatment, they were considered to have hypercholesterolemia. Finally, the following diseases diagnosed by a physician and reported by the study participant were also recorded: asthma or chronic bronchitis, coronary heart disease, stroke, diabetes mellitus, cancer at any site, and depression.

Statistical Analyses

A total of 256 study participants (6.4%) were excluded because of missing information on PA, disability, or covariates. Thus, the final analyses were conducted with 3752 individuals (2119 women). Participants in the analytic sample were younger (71.2 vs 75.7 years) and had a slightly lower percentage of women (56.5 vs 58.5%) than those who were excluded from the analysis. Baseline characteristics of the study participants by disability type are presented as mean ± *SD* or percentages.

The association of each disability type with total and CVD mortality was summarized with hazard ratios (HR) and their 95% confidence interval (CI) obtained from Cox regression. We fitted two Cox models; the first one was adjusted for sex and age (years), and the second model was further adjusted for educational attainment (no formal education, primary, secondary or higher), body mass index (kg/m^2), waist circumference (cm), systolic blood pressure (mm Hg), hypercholesterolemia (yes, no), smoking (currently, former, never), alcohol consumption (excessive, moderate, former, never), asthma or chronic bronchitis (yes, no), coronary heart disease (yes, no), stroke (yes, no), cancer (yes, no), diabetes mellitus (yes, no), and depression (yes, no).

Because the prevalence of the highest PA categories was 2.5% (n = 94) and 0.5% (n = 18), respectively, those belonging to the categories "occasional," "several times a month," and "several times a week" were merged into the same "physically active" category (ie, doing any PA). We performed independent Cox regressions with adjustment for prespecified covariates to assess whether PA (inactive, active) was associated with total and CVD mortality among older adults with specific disabilities. Next, to examine whether PA attenuates the impact of disability on total or CVD mortality, we assessed the association of the combined exposure to PA and disability with mortality by modeling four categories of exposure (active/nondisabled, active/disabled, inactive/nondisabled, inactive/disabled) and taking participants being physically active and without the specific disability type as the reference category.

The assumption of proportionality of hazards was assessed both visually and by testing the significance of interaction terms for disability type or PA with time of follow-up, and no evidence was found of departure from this assumption (all $p > .1$). All tests were two-sided and the statistical significance was set at p less than .05. Analyses were performed with STATA version 14 for Macintosh.

Results

At baseline, 58.8% of the participants had disability in agility, 43.1% in mobility, 25.0% in daily activities, 37.1% in IADL, and 18.4% in self-care. Compared to individuals without disability (Table 1), those who had any type of disability were older and more frequently women, had lower education, suffered from more chronic diseases, and were less frequently physically active (all $p < .05$). The proportion of participants with each disability type increased with age (Supplementary Figure 1).

The mean follow-up was 10.8 years (40,522 person-years), with a total of 1,727 deaths, 638 of them due to CVD. All disability types were associated with higher total and CVD mortality (Table 2), and, as expected, self-care disability had a somewhat stronger detrimental impact on both outcome variables. Specifically, compared to those without each type of disability, the full adjusted HRs (95% CI) for total mortality was 1.14 (1.01–1.28) for disability in agility, 1.31 (1.17–1.47) in mobility, 1.29 (1.15–1.46) in daily activities, 1.50 (1.33–1.70) in IADL, and 1.52 (1.34–1.73) in self-care. The corresponding HRs (95% CI) for CVD mortality were 1.30 (1.06–1.59), 1.44 (1.19–1.75), 1.29 (1.06–1.57), 1.55 (1.28–1.88), and 1.58 (1.29–1.94).

Table 3 shows total and CVD mortality according to categories of PA among individuals with specific disabilities. In full adjusted analyses, being physically active was associated with a statistically significant 26%–37% lower risk of total death and a 35%–50% lower risk of CVD death, across types of disability.

Total and CVD mortality according to joint categories of PA and disability are shown in Table 4. As compared with those being physically active and without disability, those who were inactive and had any disability showed the highest mortality from total (HRs from 1.52 to 1.90 across types of disability, $p < .05$ in all cases) and from CVD (HRs from 1.99 to 2.24 across types of disability, $p < .05$ in all cases). Physically active participants with disabilities had a total and CVD mortality risk similar to that of inactive individuals without disability; moreover, among active individuals, total mortality did not differ between those with and without agility disability; this also applied to CVD mortality among active individuals with and without restriction in daily activities.

Some sensitivity analyses were also performed. We tested if the associations of PA with total and CVD mortality among individuals with specific disabilities were independent of having other disabilities (ie, multiple disabilities) and the results did not change (Supplementary Table 1). Also, we repeated the main analyses using three PA categories (inactive, occasionally, and regularly [monthly and weekly]) and dose–response associations of PA with mortality outcomes were observed, so a higher PA may lead to a progressively lower mortality risk (Supplementary Tables 2 and 3).

Discussion

In this nationally representative sample of older adults from Spain, individuals with disability in agility, mobility, global daily activities, IADL, and self-care had increased total and CVD mortality; however, among the disabled population, being physically active was linked to lower total and CVD death risk, and PA counteracted the mortality effect of disability; indeed, physically active individuals with disability had similar mortality to those who were inactive and without disability. Taken together, these findings highlight the health benefits of PA among older adults, particularly among those with disability.

To our knowledge, this is the first study examining the impact of PA on mortality outcomes in older adults with disability. The reduced mortality associated with PA applies to total and CVD death, but was somewhat stronger for CVD. Also, our results suggest that the beneficial impact of PA on mortality varies by disability type. Several biological and psychosocial mechanisms may explain the reduced mortality associated with PA among disabled individuals. Specifically, PA has been shown to reduce obesity, low-grade inflammation, sarcopenia, frailty, falls risk, and cognitive decline, which frequently coexist with disability and worsen its vital prognosis

Table 1. Baseline Characteristics of Cohort Participants by Physical Disability Type

	Agility		Mobility		Daily Activities		IADLs		Self-care	
	No	Yes[a]	No	Yes[a]	No	Yes[a]	No	Yes[a]	No	Yes[a]
n	1545	2207	2134	1618	2813	939	2360	1392	3060	692
Women, %	44.7	64.7	50.1	65.1	46.9	66.6	51.0	65.7	54.1	67.1
Age, years	69.7 ± 7.0	73.1 ± 8.1	69.9 ± 6.9	74.1 ± 8.5	71.1 ± 7.6	73.6 ± 8.4	69.6 ± 6.7	75.3 ± 8.5	70.7 ± 7.3	76.4 ± 8.7
Educational attainment, %										
No education	41.0	59.1	44.2	61.5	48.9	59.9	44.3	64.1	48.6	65.1
Primary	40.6	32.2	40.2	29.6	37.0	31.5	39.9	28.5	37.8	26.0
Secondary or higher	18.4	8.8	15.6	8.9	14.1	8.7	15.8	7.5	13.6	8.9
Body mass index, kg/m^2	28.2 ± 4.0	29.4 ± 4.7	28.6 ± 4.2	29.3 ± 4.8	28.8 ± 4.3	29.4 ± 5.0	28.9 ± 4.2	28.9 ± 5.0	28.9 ± 4.3	29.1 ± 5.2
Waist circumference, cm	97.9 ± 11.9	99.4 ± 12.1	98.3 ± 11.2	99.5 ± 13.0	98.6 ± 11.9	99.4 ± 12.3	98.9 ± 11.5	98.7 ± 13.0	98.8 ± 11.6	99.0 ± 14.0
Systolic blood pressure, mm Hg	142.4 ± 18.1	143.7 ± 20.1	142.4 ± 18.1	143.9 ± 20.3	143.1 ± 18.7	143.5 ± 21.1	142.6 ± 18.4	144.1 ± 20.7	143.1 ± 18.8	143.5 ± 21.4
Hypercholesterolemia, %	23.3	26.3	24.9	25.3	24.8	25.9	26.7	24.0	25.2	24.6
Alcohol drinking, %										
Never	40.4	56.1	43.3	58.0	46.7	59.2	44.2	58.9	47.3	59.9
Former	10.2	13.0	10.4	13.8	11.4	13.2	10.4	14.4	11.0	15.9
Moderate	36.7	23.5	34.4	21.7	31.1	22.3	33.3	21.5	30.9	20.1
Excessive	12.7	7.4	11.9	6.6	11.1	5.3	12.1	5.2	10.8	4.1
Smoking, %										
Currently	13.4	7.7	12.0	7.5	10.9	7.5	11.8	7.1	11.2	5.3
Former	29.1	20.4	27.3	19.5	25.1	20.4	25.9	20.6	24.7	20.8
Never	57.5	71.9	60.7	73.0	63.9	72.1	62.2	72.3	64.2	74.0
Asthma/bronchitis, %	9.3	17.1	10.2	18.7	11.3	21.6	11.5	18.0	12.6	19.5
Coronary heart disease, %	3.8	7.5	4.2	8.3	4.8	9.4	4.4	8.6	4.8	11.1
Stroke, %	2.0	4.2	2.1	5.0	2.4	6.1	1.4	6.7	2.1	8.6
Diabetes, %	11.9	18.0	12.9	18.9	14.2	19.4	13.5	19.0	15.0	17.8
Cancer, %	1.0	2.4	1.4	2.5	1.4	3.3	1.2	2.9	1.8	2.2
Depression, %	6.3	13.4	8.2	13.5	8.2	17.4	8.1	14.5	9.1	16.5
Physically active, %	68.5	47.6	69.4	38.7	60.4	43.6	67.7	36.6	63.1	25.8
Occasionally, %	63.7	45.8	65.0	37.7	56.9	42.1	63.4	35.9	59.6	24.8
Monthly/weekly, %	4.8	1.8	4.4	1.0	3.5	1.5	4.3	0.7	3.5	1.0

Note: Values are mean (*SD*) or %. IADLs = Instrumental activities of daily living.
[a]Indicates having this disability type.

Table 2. Total and CVD Mortality Risk by Physical Disability Type

		Total Mortality			CVD Mortality		
	N	Deaths	Model 1 Hazard Ratio (95% CI)	Model 2 Hazard Ratio (95% CI)	Deaths	Model 1 Hazard Ratio (95% CI)	Model 2 Hazard Ratio (95% CI)
Agility							
No	1,545	605	1 (Reference)	1 (Reference)	193	1 (Reference)	1 (Reference)
Yes[a]	2,207	1,122	1.21 (1.08–1.36)	1.14 (1.01–1.28)	445	1.42 (1.17–1.74)	1.30 (1.06–1.59)
Mobility							
No	2,134	809	1 (Reference)	1 (Reference)	267	1 (Reference)	1 (Reference)
Yes[a]	1,618	918	1.38 (1.23–1.55)	1.31 (1.17–1.47)	371	1.57 (1.30–1.89)	1.44 (1.19–1.75)
Daily activities							
No	2,813	1,188	1 (Reference)	1 (Reference)	425	1 (Reference)	1 (Reference)
Yes[a]	939	539	1.39 (1.23–1.56)	1.29 (1.15–1.46)	213	1.45 (1.19–1.76)	1.29 (1.06–1.57)
IADLs							
No	2,360	842	1 (Reference)	1 (Reference)	287	1 (Reference)	1 (Reference)
Yes[a]	1,392	885	1.63 (1.45–1.83)	1.50 (1.33–1.70)	351	1.73 (1.43–2.09)	1.55 (1.28–1.88)
Self-care							
No	3,060	1,260	1 (Reference)	1 (Reference)	445	1 (Reference)	1 (Reference)
Yes[a]	692	467	1.58 (1.39–1.80)	1.52 (1.34–1.73)	193	1.70 (1.39–2.09)	1.58 (1.29–1.94)

Note: CI = Confidence interval; CVD = Cardiovascular disease; IADLs = Instrumental activities of daily living. [a]Indicates having this disability type.

Model 1 adjusted for sex and age.

Model 2 adjusted as in Model 1 and for educational attainment, body mass index, waist circumference, systolic blood pressure, hypercholesterolemia, smoking, alcohol consumption, asthma or chronic bronchitis, coronary heart disease, stroke, cancer, diabetes mellitus, and depression.

Table 3. Total and CVD Mortality According to Categories of Physical Activity in Subgroups of Older Adults With Specific Physical Disabilities

		Total Mortality			CVD Mortality		
	N	Deaths	Model 1 Hazard Ratio (95% CI)	Model 2 Hazard Ratio (95% CI)	Deaths	Model 1 Hazard Ratio (95% CI)	Model 2 Hazard Ratio (95% CI)
With agility disability							
Inactive	1,157	680	1 (Reference)	1 (Reference)	293	1 (Reference)	1 (Reference)
Active	1,050	442	0.66 (0.58–0.75)	0.69 (0.61–0.79)	152	0.54 (0.44–0.68)	0.60 (0.48–0.74)
With mobility disability							
Inactive	991	619	1 (Reference)	1 (Reference)	264	1 (Reference)	1 (Reference)
Active	627	299	0.66 (0.57–0.76)	0.68 (0.59–0.79)	107	0.57 (0.45–0.73)	0.62 (0.48–0.80)
With daily activity disability							
Inactive	530	354	1 (Reference)	1 (Reference)	154	1 (Reference)	1 (Reference)
Active	409	185	0.58 (0.48–0.71)	0.63 (0.52–0.77)	59	0.44 (0.31–0.62)	0.50 (0.35–0.71)
With IADL disability							
Inactive	882	611	1 (Reference)	1 (Reference)	250	1 (Reference)	1 (Reference)
Active	510	274	0.65 (0.56–0.76)	0.65 (0.56–0.76)	101	0.62 (0.48–0.81)	0.64 (0.49–0.83)
With self-care disability							
Inactive	513	365	1 (Reference)	1 (Reference)	159	1 (Reference)	1 (Reference)
Active	178	102	0.75 (0.61–0.94)	0.74 (0.60–0.92)	34	0.60 (0.39–0.91)	0.65 (0.43–0.99)

Note: CI = Confidence interval; CVD = Cardiovascular disease; IADLs = Instrumental activities of daily living.

Model 1 adjusted for sex and age.

Model 2 adjusted as in Model 1 and for educational attainment, body mass index, waist circumference, systolic blood pressure, hypercholesterolemia, smoking, alcohol consumption, asthma or chronic bronchitis, coronary heart disease, stroke, cancer, diabetes mellitus, and depression.

(5–8). Moreover, doing PA could improve the social network, mood status, and depression that are commonly altered in disabled patients and which have been linked to increased mortality (24–27).

Our results in disabled older adults might also be relevant for younger individuals with disability. Although it is usually accepted that many of the health benefits of PA for the general population also apply to people with specific health conditions, such benefits should be demonstrated in appropriate studies. In fact, the 2008 U.S. PA Guidelines Advisory Committee Report (8) included a separate review of the evidence in 11 disability groups (eg, lower limb loss, cerebral palsy, multiple sclerosis, muscular dystrophy, Parkinson's disease, spinal cord injury, stroke, traumatic brain injury, Alzheimer's disease, intellectual disability including Down syndrome, and mental illness) and in people with a combination of two or more disabilities. The available evidence of the effects of PA in people with these disabilities was limited to health outcomes such as cardiorespiratory fitness, lipid profile, musculoskeletal health, healthy weigh, functional level, and mental health. Mortality outcomes were not included because there were no prospective cohort studies, mainly due to limitations in identifying and recruiting subjects with these health conditions and in following them for a long period (8). As pointed out in this report (8), categorizing disabilities according to

Table 4. Total and CVD Mortality Across Joint Categories of Physical Activity and Physical Disability Type in Older Adults.

	Total Mortality Hazard Ratio (95% CI)		CVD Mortality Hazard ratio (95% CI)	
	Inactive	**Active**	**Inactive**	**Active**
Agility				
No	1.30 (1.07–1.58)	1 (Reference)	1.52 (1.05–2.19)	1 (Reference)
Yes[a]	1.52 (1.30–1.79)	1.03 (0.86–1.21)	1.99 (1.53–2.57)	1.14 (0.85–1.51)
Mobility				
No	1.27 (1.07–1.51)	1 (Reference)	1.60 (1.18–2.18)	1 (Reference)
Yes[a]	1.68 (1.44–1.94)	1.13 (0.96–1.34)	2.09 (1.64–2.67)	1.28 (0.96–1.71)
Daily activities				
No	1.35 (1.18–1.54)	1 (Reference)	1.58 (1.26–1.99)	1 (Reference)
Yes[a]	1.81 (1.53–2.13)	1.14 (0.95–1.38)	2.10 (1.63–2.71)	1.08 (0.77–1.51)
IADLs				
No	1.19 (1.01–1.40)	1 (Reference)	1.63 (1.23–2.16)	1 (Reference)
Yes[a]	1.90 (1.63–2.21)	1.25 (1.05–1.49)	2.24 (1.75–2.86)	1.43 (1.07–1.91)
Self-care				
No	1.35 (1.18–1.53)	1 (Reference)	1.60 (1.28–2.00)	1 (Reference)
Yes[a]	1.87 (1.59–2.20)	1.42 (1.15–1.76)	2.20 (1.72–2.82)	1.41 (0.92–2.15)

Note: Analyses were adjusted for sex, age, educational attainment, body mass index, waist circumference, systolic blood pressure, hypercholesterolemia, smoking, alcohol consumption, asthma or chronic bronchitis, coronary heart disease, stroke, cancer, diabetes mellitus, and depression. CI = Confidence interval; CVD = Cardiovascular disease; IADLs = Instrumental activities of daily living. [a]Indicates having this disability type.

the activity limitation rather than its cause (eg, disease), as suggested by the World Health Organization (15) and as done in the present study, may provide new and useful evidence in these understudied populations.

Although disability is considered one of the major risk factor for poor health among older adults (28,29), our results support the notion that physical inactivity may be equal or more important in aging (30–32). Paradoxically, older adults are the most physically inactive population group (33), and disabled elderly adults are even more physically inactive than their peers without disability (34–36); possibly due to their poor physical, mental, and cognitive conditions. In our study, for example, the prevalence of physical inactivity in disabled individuals was 17%–37% higher than in nondisabled participants. Given that "doing any PA is better than doing none," because even low doses of PA provide some health benefits (8), public health guidelines recommend that older adults should be as active as their abilities and conditions allow (37). Incorporating aerobic, muscle-strengthening, and balance activities into the daily routines might help to increase PA, but adjustments for each individual are surely needed according to their initial PA level or disability type and supervision (8,37).

Our study had several strengths. The UAM-cohort includes a representative sample of older adults in Spain, which allows for generalization of results. The relatively large sample size and complete follow-up made it possible to examine whether the study associations held even for the less prevalent disabilities, such as in self-care. Finally, we included five types of disability, which has allowed for assessing the impact of PA across a wide spectrum of functional limitations and their severity.

Some limitations should also be acknowledged. First, we included some types of disability, but some important functional limitations, such as in vision impairment, could be not considered. Second, although we used standardized questions, self-reported disability usually underestimates its frequency, as well as the strength of associations with mortality due to nondifferential misclassification. However, this has not precluded observing a consistent association between PA and mortality in all disability types regardless its severity. Third, although some disability types were operationalized selecting questions from previous instruments, which provide certain content validity, the specific reliability and validity of them have not been assessed. However, in the present study, we found that they have certain predictive validity (ie, disabilities were associated with long-term all-cause and CVD mortality; Table 2) as well as discriminant validity (ie, individuals with disabilities were older, more frequently women, and had more chronic conditions; Table 1 and Supplementary Figure 1). Fourth, our results on mobility disability should be confirmed by using physical performance tests (eg, gait speed, chair stand, 400-m walk). Fifth, PA was self-reported; further evidence on its health impact is needed using objective measures (eg, accelerometry). Also, PA levels could not be defined according to public health recommendations (eg, 150 minutes or 500–1,000 METs-min per week) and information on other PA patterns (eg, intensity, duration, type) was lacking. Thus, our results do not allow for establishing the amount of PA that would be needed to compensate or attenuate the excess mortality risk associated with physical disabilities. Nonetheless, our findings support PA recommendations for older adults launched by public health institutions on doing any type of PA or being active every day in as many ways as possible, regardless of their health conditions or abilities (37,38). Additionally, no information on historical PA was collected and its effect on our results is unknown; it is expected that inactive older adults who were physically active throughout the adulthood would have better health than those who were inactive (39). And sixth, analyses in Supplementary Tables were based on relatively small samples, with only a few deaths in some strata. This has precluded a formal testing of differences in hazard ratios of mortality between specific categories of PA.

In conclusion, in older adults, PA could attenuate the increased risk of mortality associated with physical disabilities. Since short- and medium-term changes in health status (eg, disability, chronic conditions) and PA levels may still occur throughout the old age, future research needs to examine the effect of changes in PA on health outcomes in the aging populations. Also, these findings must be examined in contemporary cohorts because recent technological advances (eg, e-health and m-health) and new daily living aids, as well as national initiatives to promote PA, might be affecting the relationships between PA, disability, and survival.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

Funding

This work was supported by FIS grants 12/1166 and 13/0288 (Instituto de Salud Carlos III, State Secretary of R+D+I and FEDER/FSE), MINECO R+D+I grant (DEP2013-47786-R), MECD mobility grant (JC2015-00080), the FRAILOMIC Initiative (European Union FP7-HEALTH-2012-Proposal No. 305483-2), and the ATHLOS project (European project H2020- Project ID:635316).

Conflict of Interest

None declared.

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